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SECTION 6
NETWORK INFRASTRUCTURE END-TO-END PERFORMANCE

6.1 INTRODUCTION

This section focuses on the Wide Area Network (WAN) performance characteristics for Layer 3 routers and switches used in the End-to-End (E2E) Unified Capabilities (UC) network infrastructure. It defines the Differentiated Services Code Point (DSCP) Plan, Per-Hop Behavior (PHB) policy and priority as applied to packets based on the granular service class when traversing a Defense Information Systems Network (DISN) network hop, and traffic conditioning treatment requirements that are to be given to network queues. These requirements are additional to those defined in other sections of this document as follows:

1. Assured Services Local Area Network (ASLAN) Infrastructure requirements [i.e., Local Area Network (LAN) Core, Distribution, and Access switches; Customer Edge (CE) Routers (CE-Rs)] as defined in Section 7, Network Edge Infrastructure.

2. Network Infrastructure product requirements (i.e., DISN Router, Switch, and Access Elements) as defined in Section 10, Network Infrastructure Products.

3. E2E network design guidelines as described in Department of Defense (DoD) UC Framework 2013, Section 6.

A summary of network performance requirements as described in the UC Framework document is included in , Network Infrastructure Design Synopsis, as a reference.

6.1.1 Network Infrastructure Design Synopsis

The E2E network infrastructure consists of three network segments: the CE, Network Edge, and Core. These are illustrated in and described in detail in DoD UC Framework 2013, Section 6.
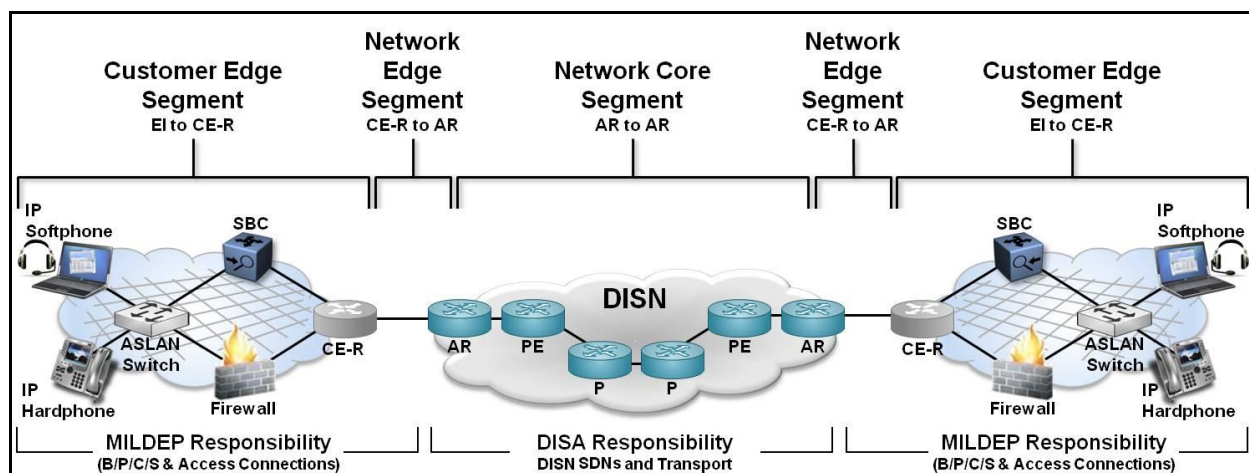

Figure 6.1-1. UC E2E Network Segments and Measurement Reference Points

6.2 GENERAL NETWORK

The primary performance driver for voice products in the DISN is the E2E voice quality.

WAN-000010 [**Required**] Voice quality shall be calculated E2E from handset to handset using the E-Model as described in the Telecommunications Industry Association (TIA)/ Telecommunication Standardization Bureau (TSB)-116 A, which is based on recommendation G.107.

6.3 PER-HOP BEHAVIOR AND SERVICE-LEVEL OBJECTIVE (SLO)

The Differentiated Services (DS) Architecture uses the terms Per-Hop Behavior (PHB) and Service Level Objective (SLO) to describe a service convention that specifies the forwarding service a customer should receive. The SLO includes service and traffic conditioning parameters and rules that constitute the overall design. The SLO is divided into Service-Level Specification (SLS), Traffic Conditioning Specification (TCS), and Traffic Conditioning Agreement (TCA). These rules are defined in Request for Comments (RFC) 3260, which updates RFCs 2474, 2475, and 2597.

6.3.1 Service-Level Specification (Previously Summary of Granular Service Class Performance Objectives)

The SLS is a set of parameters whose values together define the minimum acceptable service to be offered to a pre-determined network segment based on pre-defined Granular Service Classes.

Table 6.3-1, Service-Level Specification, summarizes the SLS for each granular UC service class as defined in DoD UC Framework 2013, Section 6. This table defines one-way performance requirements.

Table 6.3-1.   Service-Level Specification

GRANULAR SERVICE CLASS	E2E LATENCY (MS)	AR-AR LATENCY (MS)	EI-CER LATENCY (MS)	E2E PACKET LOSS (%)	AR-AR PACKET LOSS (%)	EI-CER PACKET LOSS (%)	E2E JITTER (MS)	AR-AR JITTER (MS)	EI-CER JITTER (MS)
Short Messaging	1000	900	50	0.5	0.4	0.05			
Assured Voice	220	150	35	1	0.8	0.05	20	14	3
Assured Multimedia Conferencing	220	150	35	1	0.8	0.05	20	14	3
Broadcast Video	1000	900	50	0.1	0.08	0.01			
Multimedia Streaming (includes Non-Assured Video)	250	180	35	1	0.8	0.05	20	14	3

GRANULAR SERVICE CLASS	E2E LATENCY (MS)	AR-AR LATENCY (MS)	EI-CER LATENCY (MS)	E2E PACKET LOSS (%)	AR-AR PACKET LOSS (%)	EI-CER PACKET LOSS (%)	E2E JITTER (MS)	AR-AR JITTER (MS)	EI-CER JITTER (MS)
Non-Assured Voice	250	180	35	1	0.8	0.05	20	14	3
Low Latency Data: Instant Messaging (IM)/Chat, Presence	300	200	50	1	0.8	0.05			
High Throughput Data: Real-Time Data Backup, Web Hosting	300	200	50	1	0.8	0.05			
NOTE: Not All Aggregate Service Classes Have Performance Objectives (Best Effort, Signaling, Network Control, and Low Priority)									

WAN-000020 [**Required**] Products that provide UC services shall support the SLS based on the Granular Service Class as defined in Table 6.3-1, Service-Level Specification.

6.3.2   Traffic Conditioning Specification

The TCS is a set of parameters whose values together specify the DSCP classifier rules and traffic profiles for Aggregate and Granular Service Classes within DoD.

WAN-000030 [**Required**] Products that provide UC services shall support the TCS, which defines the DSCP Plan used in the DoD and is shown in Table 6.3-2, Traffic Conditioning Specification.

Table 6.3-2.   Traffic Conditioning Specification

AGGREGATED SERVICE CLASS	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	DSCP BINARY	DSCP BASE8
Network Control	Network Signaling (OSPF, BGP, etc.)	N/A	48	110 000	60
Inelastic Real-Time	User Signaling (AS-SIP, H.323, etc.)	N/A	40	101 000	50
	Short Message	FO	32	100 000	40
	Assured Voice (Includes SRTCP)	FO	41	101 001	51
		F	43	101 011	53
		I	45	101 101	55
		P	47	101 111	57
		R	49	110 001	61
	Non-Assured Voice*	N/A	46	101 110	56
	Assured Multimedia	FO	33	100 001	41

AGGREGATED SERVICE CLASS	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	DSCP BINARY	DSCP BASE8
	Conferencing (voice, video, and data) (code points 28, 30, 34, 36, and 38 are for Non-Assured Multimedia Conferencing)	F	35	100 011	43
		I	37	100 101	45
		P	39	100 111	47
		R	51 [28, 30, 34,36,38]**	110 011	63
	Broadcast Video	N/A	24	011 000	30
Preferred Elastic	Multimedia Streaming	FO	25	011 001	31
		F	27	011 011	33
		I	29	011 101	35
		P	31	011 111	37
		R	26	011 010	32
	Low-Latency Data: (IM, Chat, Presence)	FO	17	010 001	21
		F	19	010 011	23
		I	21	010 101	25
		P	23	010 111	27
		R	18 [20,22]**	010 010	22
	High Throughput Data (Real-Time Data Backup, Web Hosting)	FO	9	001 001	11
		F	11	001 011	13
		I	13	001 101	15
		P	15	001 111	17
		R	10 [12,14]**	001 010	12
	OA&M	N/A	16	010 000	20
Elastic	Best Effort	N/A	0	000 000	00
	Low Priority Data	N/A	8	001 000	10

LEGEND:

AS-SIP: Assured Services Session Initiation Protocol   N/A: Not Applicable

BGP: Border Gateway Protocol   OA&M: Operations, Administration, and Maintenance

DSCP: Differentiated Services Code Point   OSPF: Open Shortest Path First

F: FLASH   P: PRIORITY

FO: FLASH OVERRIDE   R: ROUTINE

IM: Instant Messaging   SRTCP: Secure Real-Time Transport Control Protocol

I: INTERMEDIATE

*   For a definition, see UC Framework 2013, Appendix C, Definitions, Abbreviations and Acronyms, and References.

AGGREGATED SERVICE CLASS	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	DSCP BINARY	DSCP BASE8
** Code points in brackets are reserved for nonconformance marking.					

WAN-000040 [**Required**] DS assignments shall be software configurable for the full range of six-bit values (0–63 Base10) for backwards compatibility with Internet protocol (IP) precedence environments that may be configured to use the Type of Service (TOS) field in the IP header but that do not support DSCP.

WAN-000050 [**Conditional**] If Layer 3 devices supporting UC services are configured with interfaces T1 and below or on routers that do not support the six-queue model, then Layer 3 devices shall support configuration of the four-queue PHBs, as defined in Table 6.3-3, Four-Queue PHB Approach. Otherwise, the system routers supporting UC services shall support configuration of the six-queue PHBs as defined in Table 6.3-4, Six-Queue PHB Approach.

Table 6.3-3.   Four-Queue PHB Approach

QUEUE	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	PHB
3	Network Signaling (See Note)	N/A	48	EF
	User Signaling	N/A	40	
	Short Message	FO	32	
	Assured Voice	FO	41	
		F	43	
		I	45	
		P	47	
		R	49	
2	Assured Multimedia Conferencing (Assured Video Conferencing)	FO	33	AF41
		F	35	
		I	37	
		P	39	
		R	51	
1	Broadcast Video	N/A	24	AF31
	Non-Assured Voice*	N/A	46	
	Multimedia Streaming (Video Streaming)	FO	25	
		F	27	
		I	29	
		P	31	
		R	26	
	Non-Assured Multimedia Conferencing	FO	28	
		F	30	

QUEUE	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	PHB
	(Non-Assured Video Conferencing)	I	34	
		P	36	
		R	38	
	Low-Latency Data (IM, Chat, Presence)	FO	17	
		F	19	
		I	21	
		P	23	
		R	18 [20,22]**	
	High Throughput Data (Real-Time Data Backup, Web Hosting)	FO	9	AF32
		F	11	
		I	13	
		P	15	
		R	10 [12,14]**	
	OA&M	N/A	16	
0	Best Effort	N/A	0	Default
	Low Priority	N/A	8	
NOTE:	Many routers have a separate non-configurable queue for network control traffic. If a router does not have the network control queue, the network control traffic would be processed in the EF queue.			

LEGEND:

AF: Assured Forwarding	I: IMMEDIATE	OSPF: Open Shortest Path First
DSCP: Differentiated Services Code Point	IM: Instant Messaging	P: PRIORITY
EF: Expedited Forwarding	IS-IS: Intermediate System-to-Intermediate System Protocol	PHB: Per Hop Behavior
F: FLASH	N/A: Not Applicable	R: ROUTINE
FO: FLASH OVERRIDE	OA&M: Operations, Administration, and Maintenance	

* For a definition, see UC Framework 2013, Appendix C, Definitions, Abbreviations and Acronyms, and References.

** Code points in brackets are reserved for nonconformance marking.

Table 6.3-4.   Six-Queue PHB Approach

QUEUE	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	CER PHB
5	Network Signaling (See note)	N/A	48	
4	User Signaling	N/A	40	EF
	Short Message	FO	32	

QUEUE	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	CER PHB
	Assured Voice	FO	41	
		F	43	
		I	45	
		P	47	
		R	49	
	Assured Multimedia Conferencing (Assured Video Conferencing)	FO	33	
		F	35	
		I	37	
		P	39	
		R	51	
3	Broadcast Video	N/A	24	
	Non-Assured Voice*	N/A	46	
	Non-Assured Multimedia Conferencing (Non-Assured Video Conferencing)	FO	28	
		F	30	
		I	34	
		P	36	
		R	38	
2	Multimedia Streaming (Video Streaming)	FO	25	AF
		F	27	
		I	29	
		P	31	
		R	26	
	Low-Latency Data (IM, Chat, Presence)	FO	17	
		F	19	
		I	21	
		P	23	
		R	18 [20,22]**	
	High Throughput Data (Real-Time Data Backup, Web Hosting)	FO	9	
		F	11	
		I	13	
		P	15	
		R	10 [12,14]**	
	OA&M	N/A	16	
1	Best Effort (Default)	N/A	All Remaining	BE
0	Low Priority	N/A	8	

QUEUE	GRANULAR SERVICE CLASS	PRIORITY/ PRECEDENCE	DSCP BASE10	CER PHB
NOTE:	Many routers have a separate non-configurable queue for network control traffic. If a router does not have the network control queue, the network control traffic would be processed in the EF queue.			

LEGEND:		
AF: Assured Forwarding	FO: FLASH OVERRIDE	R: ROUTINE
CER: Customer Edge Router	I: IMMEDIATE	N/A: Not Applicable
DSCP: Differentiated Services Code Point	IM: Instant Messaging	OA&M: Operations, Administration, and Maintenance
EF: Expedited Forwarding	P: PRIORITY	
F: FLASH	PHB: Per Hop Behavior	

*   For a definition, see UC Framework 2013, Appendix C, Definitions, Abbreviations and Acronyms, and References.

** Code points in brackets are reserved for nonconformance marking.

WAN-000060 [**Required**] The same queuing model (six or four) shall be configured at both ends of the communication path to prevent asymmetrical performance.

> NOTE: The Communication path for this requirement is defined from the egress interface of the local CE-R to the ingress interface of the remote CE-R.

WAN-000070 [**Required**] Bandwidth allocation and negotiation needs to occur between the Aggregation Router (AR) and the CE-R to prevent asymmetrical performance.

> NOTE: The purpose of this requirement is to prevent back throttling, delay, jitter, or drop packets on EF queues because of asymmetrical queue configuration between the CE-R and the AR.

WAN-000080 [**Required**] The CE-R bandwidth budget must be less than or equal to the AR bandwidth budget per queue.

> NOTE 1: For example, if a Session Controller (SC) session budget is 10 voice sessions, then the CE-R bandwidth budget for the EF queue must be greater than 1,100 kbps (10 x 110 kbps). If the CE-R bandwidth budget was, for example, 1400 kbps to account for expected growth, surge, or other unplanned EF traffic, then the AR bandwidth must be greater than 1400 kbps or greater than the CE-R bandwidth budget. The SC session budget must be less than the equivalent CE-R bandwidth budget, in the scenario previously described, less than 1400 kbps.

> NOTE 2: PHB requirements are outlined in RFC 3246 and RFC 3260.

6.3.3 Traffic Conditioning Agreement (Previously Traffic Conditioning Requirements)

The TCA is the convention for how classifier rules and profiles defined by the TCS are metered, provisioned, marked, discarded and shaped based on the type of Aggregate or Granular service class.

WAN-000090 [**Required**] All CE-R and/or AR egress interfaces in the direction of the DISN shall mark packets in accordance with the TCS as defined in Section 6.3.2, Traffic Conditioning Specification (Previously Differentiated Services Code Point Plan).

WAN-000100 [**Required**] All CE-R and/or AR egress interfaces in the direction of the DISN shall support configuration of network queues in accordance with the TCS as defined in Table 6.3-2, Traffic Conditioning Specification, on an Aggregate Service class perspective on the input interface.

> NOTE: When other queues are not saturated, the Best Effort traffic may surge beyond its traffic-engineered limit.

WAN-000110 [**Required**] All CE-R and/or AR egress interfaces in the direction of the DISN shall support configuration of network queues in accordance with the TCS as defined in Table 6.3-2, Traffic Conditioning Specification, on an Aggregate Service class perspective on the output interface.

> NOTE: When other queues are not saturated, the Best Effort traffic may surge beyond its traffic-engineered limit.

WAN-000120 [**Required**] All CE-R and/or AR egress interfaces in the direction of the DISN shall have the capability to perform traffic conditioning as per the definition in DoD UC Framework 2013, Appendix C, Definitions, Abbreviations and Acronyms, and References.

> NOTE 1: It is beyond the scope of this document to mandate specific bandwidth throttling, rate limiting or discarding mechanisms to manage congestion. It is up to the discretion of the Network Administrator to make the appropriate determination for the individual network.

> NOTE 2: General Traffic Conditioning guidelines and considerations can be found in UC Framework 2013, Section 6.12, UC Network Infrastructure Survivability.

WAN-000130 [**Required**] The product shall calculate or be configurable to support bandwidth metering and provisioning.

> NOTE: Queue size should account for the Layer 3 header (i.e., IP header) but not the Layer 2 headers (i.e., Point-to-Point Protocol [PPP]; MAC, etc.) within a margin of error of 10 percent, analogous as to how packet size is calculated for transmission IAW RFC 3246, Section 2.2.

WAN-000140 [**Required**] The system Layer 3 devices shall be able to traffic condition using IP addresses, protocol port numbers, and DSCPs as discriminators, at a minimum.

> NOTE: The definition of traffic engineering is found in DoD UC Framework 2013, Appendix C, Definitions, Abbreviations and Acronyms, and References.

6.4   VVOIP NETWORK INFRASTRUCTURE NETWORK MANAGEMENT

The Voice and Video over Internet Protocol (VVoIP) Network Infrastructure Network Management (NM) requirements have been relocated to Section 2.19, Management of Network Appliances.